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APPLICANTS: THOMAS PIKE, IAN STANDLEY AND AMADEJ TRNKOCZY

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TITLE: MICRO-MACHINED ACCELEROMETER

EXAMINER: BELLAMY, TAMIKO D.

GROUP ART: 2856

ATTY DCKT NO: 01-10-1758

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AMENDMENTS

Applicants hereby respectfully request that the Examiner cancel currently pending claims 2 through 22 and replace them with new Claims 23 through 37, as follows:

23. (New) An accelerometer comprising:

a transducer for determining the position of a proof mass relative to a fixed plate by determining a coupling capacitance between a first capacitive sensor array on a surface of said fixed plate and a second capacitive sensor array on the surface of said proof mass,

an actuator for generating and emitting an actuation signal in order to move said proof mass; and

feedback electronics for using said proof mass

position as determined by said transducer in order to produce a feedback signal in order to control said actuator, thereby managing the actuation signal and controlling the motion of said proof mass within desired parameters.

a means for measuring the actuation signal and determining an acceleration component of the movement of the proof mass as a function thereof.

24. (New) The accelerometer of claim 23, wherein the feedback signal controls the actuator in order to maintain said proof mass in approximately a null position within one cycle of said transducer.

25. (New) The accelerometer of claim 23, further comprising a velocity sensor comprising a means for determining a velocity component for the movement of said proof mass by measuring the voltage within said feedback electronics and calculating the velocity component as a function of such measurement.

26. (New) The accelerometer of claim 23, further comprising:

limit control electronics for receiving said actuation signal generated by the actuator and temporarily zeroing said actuation signal if said actuation

signal exceeds a preset limit corresponding to movement of said proof mass of a distance substantially more than one half a repeat distance of said transducer.

27. (New) The accelerometer of claim 23, wherein the proof mass is supported by a plurality of flexural elements, said flexural elements constraining movement of said proof mass to a single direction or axis.

28. (New) The accelerometer of claim 27 wherein the flexural elements allow in plane movement in two directions, said in plane movement detected by a second set of separate sensor arrays aligned in periodicity to said two directions.

29. (New) The accelerometer of claim 23, wherein the actuator is an electrostatic actuator.

30. (New) The accelerometer of claim 29, wherein the electrostatic actuator includes a set of actuator plates, one positioned on the fixed plate and one on the proof mass, said plates arranged to receive the actuating signal and generate a force sufficient to move the proof mass.

31. (New) The accelerometer of claim 30, wherein the force generated as a linear function of said actuating signal.

32. (New)The accelerometer of claim 23, wherein the actuator is an electromagnetic actuator.

33. (New) The accelerometer of claim 32 wherein the electromagnetic actuator includes:

a fixed external magnetic circuit having two magnet sets on each side of the proof mass;

main feedback coil and an integrator feedback coil on said proof mass;

external feedback circuitry using said proof mass position determined from said transducer, said feedback circuitry providing separate feedback currents to said main feedback coil and said integrator feedback coil in order to stimulate electro-magnetic interactions between the two coils and magnets, thereby controlling the movement and position of the proof mass, said main feedback coil and said integrator feedback coil nulling velocity input signals and position input signals to said transducer; and

limit control electronics for temporarily zeroing said feedback current provided to said integrator feedback coil when said current exceeds a preset

limit corresponding to movement by the proof mass, in either direction, of a distance greater than one half of a repeat distance of said transducer.

34. (New) The accelerometer of claim 33 wherein said proof mass is comprised of two wafers bonded together and said integrator feedback coil is located centrally between said two wafers to provide symmetric actuation.

35. (New) The accelerometer of claim 33 with said external feedback circuitry driving said main feedback coil and said integrator feedback coil in a transconductance configuration.

36. (New) The accelerometer of Claim 29 having an additional electrostatic actuator to provide a calibration input.

37. (New) The accelerometer of Claim 32 having an additional electromagnetic actuator to provide a calibration input.

RESPONSIVE ARGUMENTS

Applicants have amended the claims to bring them into conformity with office practice. They have not been amended to overcome any form of prior art or invalidity arguments and no new limitations have been added. In all cases, the amendments are not narrowing amendments. Accordingly, none of the amendments is intended to narrow the claim scope of what may or may not be considered an equivalent.

REJECTIONS UNDER 35 U.S.C. §103

The Examiner has rejected Claims 1 through 22 as being unpatentable and obvious under 35 U.S.C. 103(a) in light of *Tang* (U.S. Patent No. 5,447,068). Applicants respectfully disagree with the Examiner and traverse this rejection.

Claim 1 in the application specifically provides that "a first capacitive sensor array ***on the surface of said fixed plate,*** said first capacitive sensor array having a periodic pattern of conductive elements. Claim 1 further provides "a suspension plate with a proof mass supported by ***a plurality of flexural elements*** engaging a frame" and "a second capacitive sensor array ***on a surface of said proof mass.***" Finally, Claim 1 further provides "an electrical connection to said first capacitive sensor array on said fixed plate allowing a coupling of cyclic excitations from external electronics through said periodic pattern of said first capacitive sensor array to said periodic pattern of said second capacitive sensor array, said

coupling ranging between zero and one hundred percent and being a ***cycling positional measure of said proof mass with respect to said fixed plate*** in said constrained planar direction" and "an electrical connection to said proof mass sensor array transmitting a signal resulting from said coupling of said fixed plate sensor array to said proof mass sensor array to external electronics ***for determination of percentage of said coupling and transduce the position of said proof mass***." As is evident, none of these elements are taught or even suggested by *Tang*.

First, *Tang* clearly teaches the used of three (3) different plates and three different capacitive arrays. Two fixed position arrays position, one on each side of the proof mass and an array that extends from the proof mass. Additionally, *Tang* also teaches that each capacitive array has two separate sets of electrodes. As *Tang* explains, these electrodes are used to measure forward and backward movement and "are connected in parallel to boost sensitivity and to lower drive requirement." *Tang* at col. 4, ln. 40-41. "The two sets of interconnected electrodes (labeled as 'forward electrodes" an 'backward electrodes') operate differentially." Accordingly, both sets of electrodes are needed to determine any acceleration in the x direction. *Tang* at col. 4, ln. 44-46.

Through the use of all three plates, *Tang* teaches that a differential capacitive accelerometer is formed:

> In the preferred embodiment, plates 26 and 32 are combined with a third plate 38 to form a differential capacitive accelerometer.

As explained by *Tang*, the movement of the proof mass is determined over an entire cycle. During the first half of this cycle voltage is applied across the top plate or set of top electrodes and the distance between the top plates and the plates extending from the proof mass is measured. During a second half of the cycle, voltage is applied across the bottom place or the bottom set of electrodes and the distance between the bottom plate and the plates extending from the proof mass are measured. These two readings are then compared to determine the difference in position and calculate velocity/acceleration.

Unlike *Tang*, the invention claimed in Claim 1 requires only two capacitive arrays to form a differential capacitive accelerometer. It does not require a third capacitive array. Moreover, in the claimed invention, each array does not require parallel electrodes. Finally, the claimed invention need only measure the coupling between the capacitive array on the proof mass and the capacitive array on the fixed plate ***for determination of percentage of said coupling and in order to transduce the position of said proof mass.***"

All of these differences are significant and it cannot be said that *Tang* teachs, hints, or suggests any modification to accomplish all of these particular claimed elements.

Additionally, in *Tang*, the first capacitive sensor is not formed ***on the surface of the fixed plate***. Instead, the fixed capacitive sensor in *Tang* ***extends from*** the surface of the fixed plate. Moreover, in the present invention the capacitive sensor is one flat surface wherein the capacitive sensor in *Tang* specifically includes two surfaces aligned at acute angels. *Tang* at col. 3, ln. 14-16.

Likewise, the second capacitive sensor in *Tang* is not formed ***on the surface of the proof mass***. Instead, the fixed capacitive sensor in *Tang* ***extends from the proof mass*** (on opposite sides of the proof mass) with each capacitive plate also having two surfaces aligned at the same acute angels. *Tang* at col. 3, ln. 24-27.

Finally, as explained above, *Tang* specifically teaches the use of a third capacitive array in order to determine acceleration using a differential approach which is not the same as the present invention. This third capacitive array also extends from the surface of a third plate, this third capacitive array also having two surfaces aligned at the same acute angels. *Tang* at col. 3, ln. 27-30.

As the specification of *Tang* makes clear, this dual surface at arranged at acute angels is a key feature of the invention described

in *Tang* and it would not be obvious to alter the design in *Tang* to form these capacitive sensors on the surface of the fixed plate and the surface of the proof mass because then they would not have the same angular design which is a key feature of *Tang*.

Finally, Claim 1 includes "***a plurality of flexural elements*** engaging a frame" which support the proof mass. As the specification explains, the suspension plate is machined through its thickness to produce these flexural elements. *Tang* uses a conventional cantilever suspension for supporting the proof mass. Applicants submit a conventional cantilever support is not the same as the flexural elements described and claimed in the present invention.

For all off these reasons, Claim 1 is clearly distinguishable over the teachings of *Tang*. Accordingly, Applicants submit that Claim 1 should be allowed.

Claim 2 has been replaced with Claim 23. Claim 23 includes the very same allowable limitations discussed above with reference to Claim 1. Accordingly, Claim 23 is also allowable.

Claims 24 through 37 all depend, either directly or indirectly, from Claim 23. Accordingly, each is allowable by virtue of its dependency. Additionally, each of the claims contains independently allowable subject matter. For example, Claim 32 makes clear the actuator is an electromagnetic actuator. *Tang* does not teach,

suggest or even hint the use of an electromagnetic actuator.

Additionally, Claim 33 explicitly provides that the electromagnetic actuator includes a fixed external magnetic circuit having two magnet sets on each side of the proof mass and a main feedback coil and an integrator feedback coil on said proof mass. Claim 33 further provides that the electromagnetic actuator includes feedback circuitry that provides separate feedback currents to said main feedback coil and said integrator feedback coil in order to stimulate electro-magnetic interactions between the two coils and magnets, thereby controlling the movement and position of the proof mass. *Tang* does not teach, suggest or even hint these limitations.

Accordingly, Applicants submit that all claims are allowable over the teachings of *Tang* and immediate allowance should be granted. If the Examiner has any questions with regard to the amendments or arguments presented herein, the Examiner is strongly encourage to contact the undersigned attorney in order to discuss any further action.

Respectfully submitted,

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FROM: J. CARR

DATE: 10/20/2003 PAGES (including this page): 15

RE: Response to Office Action

MESSAGE:

Dear Sir,

Enclosed please find the following:

1. Response / Amendment - responsive to communication dated 6/25/2003
2. Petition for Extension of Time (2 copies)
3. Credit Card Payment Form